Model Based Systems Engineering

Best Practice From Space

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DLR

We Want to Do Model Based Systems Engineering – Now what…

Model based Systems Engineering is More Than Installing a Tool

Several times a year on the telephone:

„Hi Phil! We want to do MBSE in our Company and downloaded Virtual Satellite but we don‘t understand how it works…“

- There is not one answer of MBSE to your questions

- And don‘t start modelling for the sake of modelling!
  - Ask yourself what you want to do with it?
  - What is your envisaged return of investment?

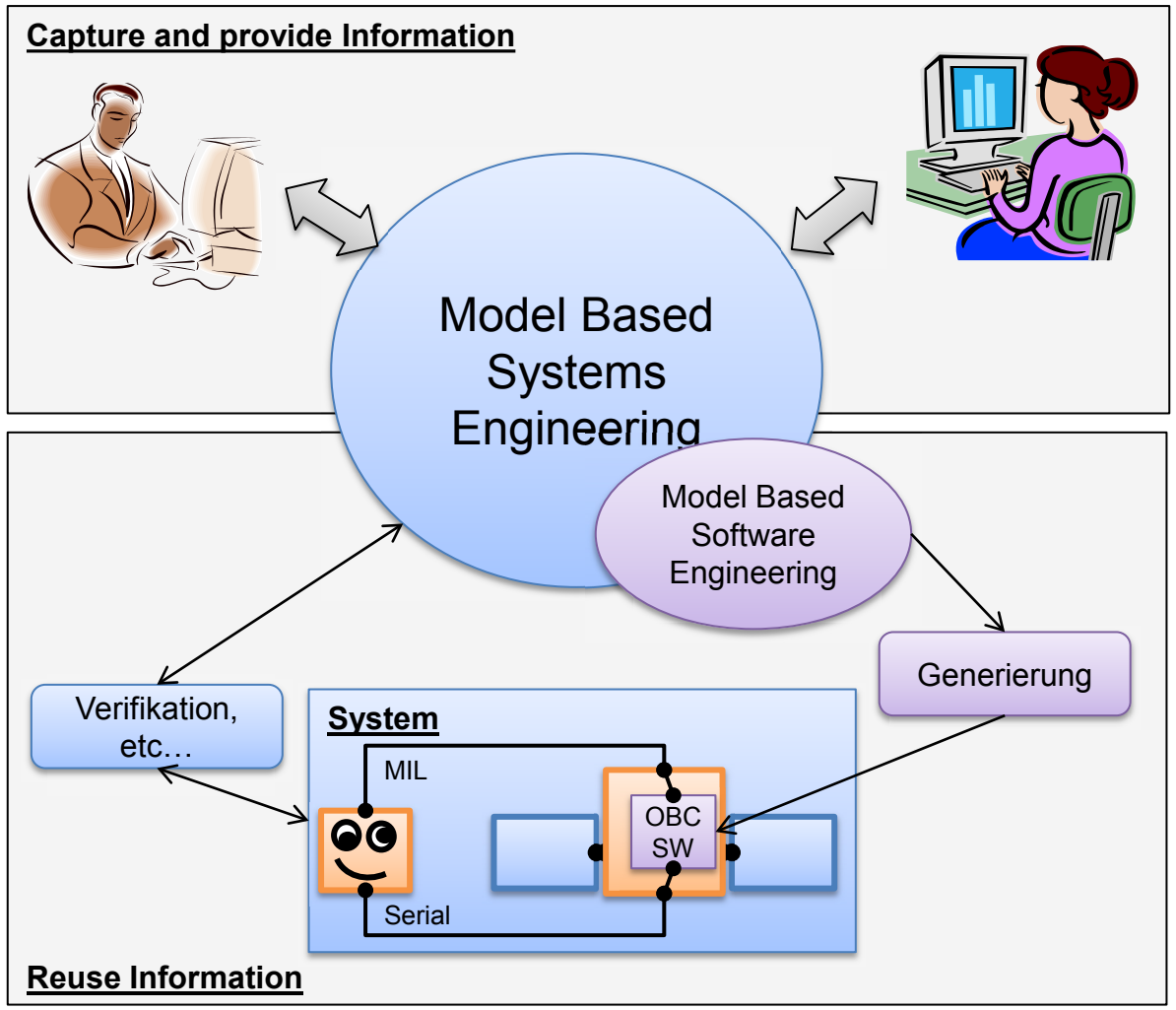
Alright, so What is Model Based Systems Engineering

MBSE in our Context is Some of the Following…

- For us there is no clear cut definition of MBSE:
  - Model Based Systems Engineering
  - Model Based Software Engineering
  - But also Process/Workflow Automation

- Anyway all of them target to …
  - … collect information
  - … improve consistency of information
  - … centralize information
  - … control information flow

- *Altogether, the extra task of modelling should deliver a benefit in time, efficiency, money, etc. to you!*



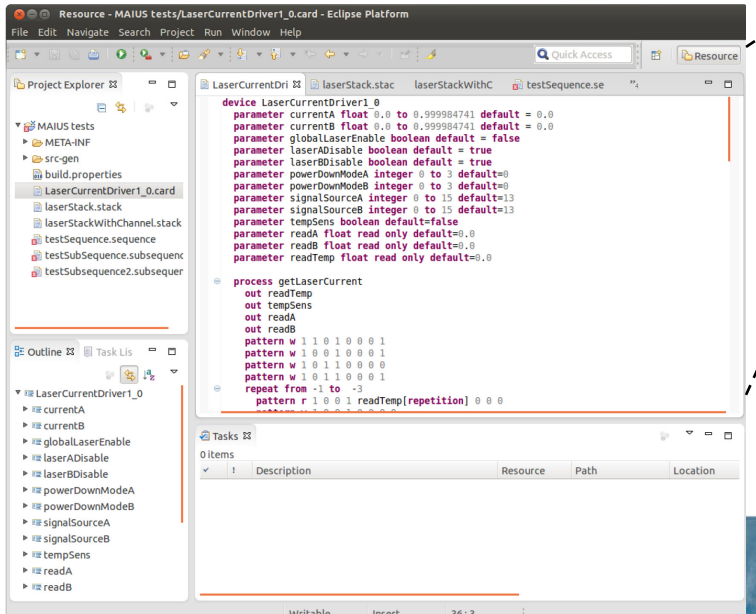
Early Spacecraft Design has an Intense Information Exchange
MBSE Helps to Organize, Structure and Analyze the Information

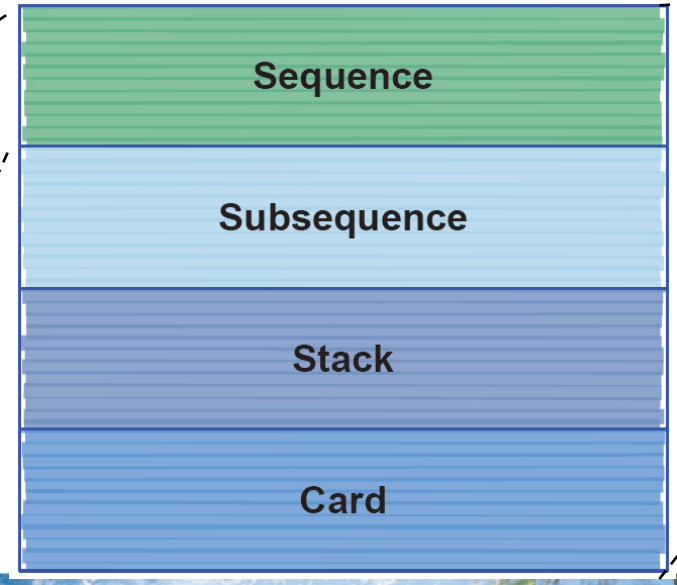
*) P. M. Fischer, M. Deshmukh, V. Maiwald, D. Quantius, A. Martelo Gomez, A. Gerndt, (2017) *Conceptual data model: A foundation for successful concurrent engineering*, Concurrent Engineering Research and Application. DOI: 10.1177/1063293X1773459

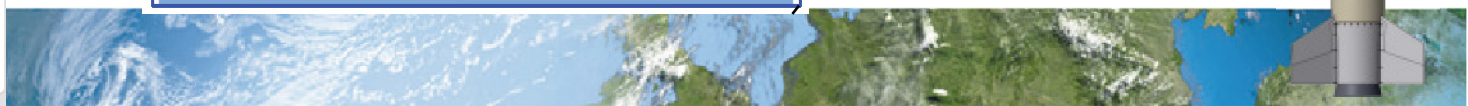
A Model for Understanding Each Other

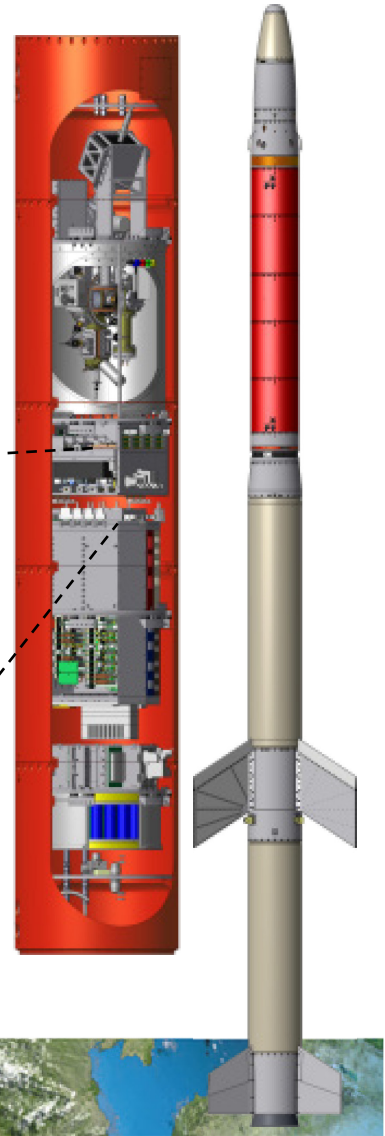
MBSE for the Purpose of Code Generation

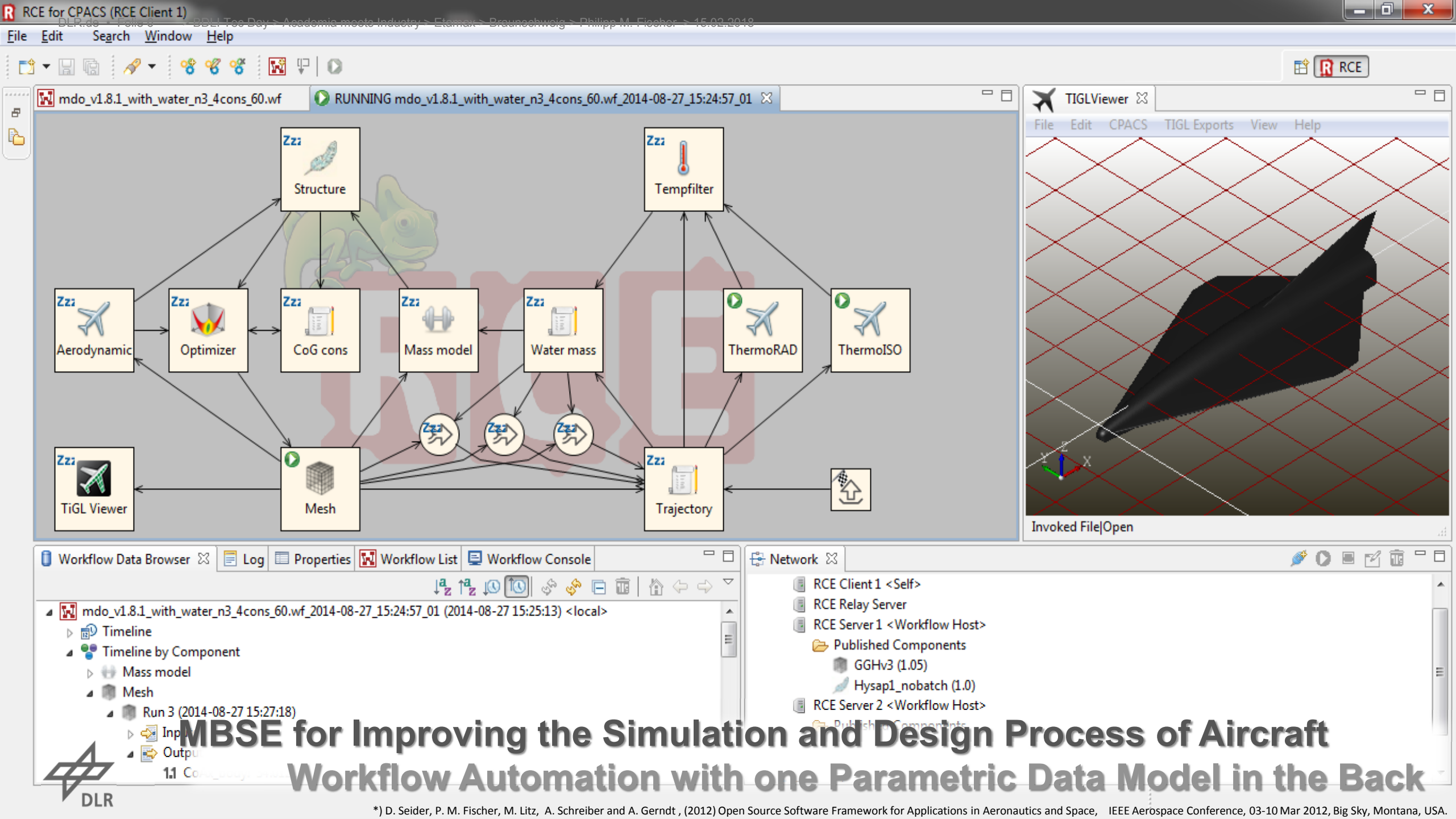
- Scientists don‘t understand the engineers an the engineers don‘t understand the scientists.
- Introducing MBSE with a textual model as a formal language to describe the execution of the scientific experiment.
- The engineers‘ code generator uses the model to generate on board software from the model.





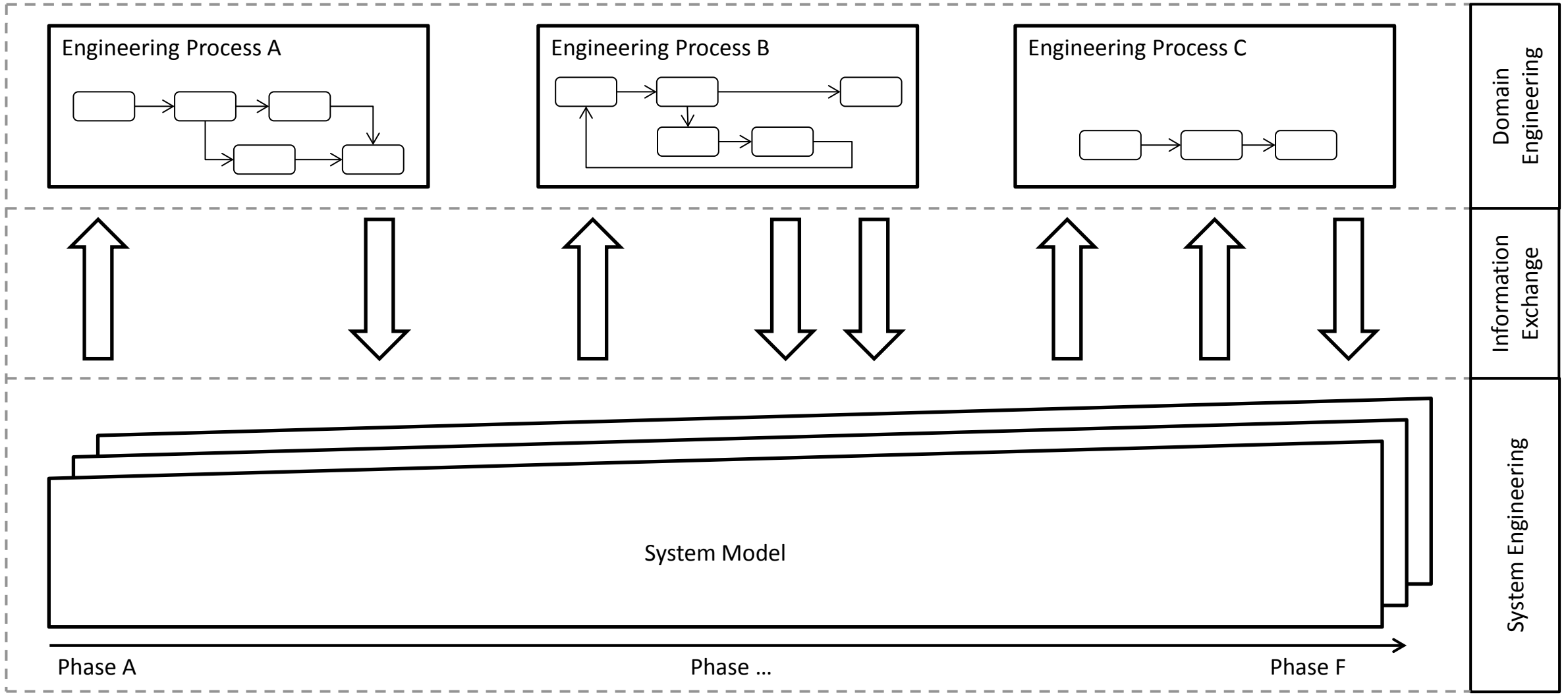





RCE for CPACS (RCE Client 1)
File Edit Search Window Help
RCE
mdo_v1.8.1_with_water_n3_4cons_60.wf
RUNNING mdo_v1.8.1_with_water_n3_4cons_60.wf_2014-08-27_15:24:57_01
Structure
Tempfilter
Aerodynamic
Optimizer
CoG cons
Mass model
Water mass
ThermoRAD
ThermoISO
TiGL Viewer
Mesh
Trajectory
TIGLViewer
File Edit CPACS TIGL Exports View Help
Invoked File|Open
Workflow Data Browser
Log
Properties
Workflow List
Workflow Console
mdo_v1.8.1_with_water_n3_4cons_60.wf_2014-08-27_15:24:57_01 (2014-08-27 15:25:13) <local>
Timeline
Timeline by Component
Mass model
Mesh
Run 3 (2014-08-27 15:27:18)
Network
RCE Client 1 <Self>
RCE Relay Server
RCE Server 1 <Workflow Host>
Published Components
GGHv3 (1.05)
Hysap1_nobatch (1.0)
RCE Server 2 <Workflow Host>
MBSE for Improving the Simulation and Design Process of Aircraft
Workflow Automation with one Parametric Data Model in the Back
DLR
*) D. Seider, P. M. Fischer, M. Litz, A. Schreiber and A. Gerndt , (2012) Open Source Software Framework for Applications in Aeronautics and Space, IEEE Aerospace Conference, 03-10 Mar 2012, Big Sky, Montana, USA.

MBSE Aims for Data Continuity Through the whole Life of a Spacecraft

Identifying Todays and Tomorrows Information to be Exchanged

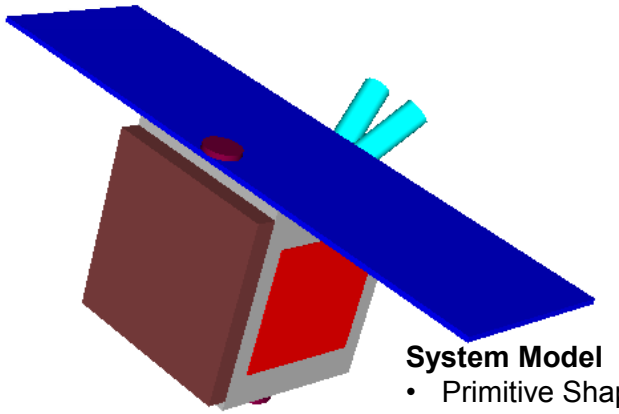


*) P. M. Fischer, D. Lüdtke, C. Lange, F.-C. Roshani, F. Dannemann, A. Gerndt, (2017) Implementing model-based system engineering for the whole lifecycle of a spacecraft, CEAS Space Journal, DOI: 10.1007/s12567-017-0166-4 ISSN 1868-2502

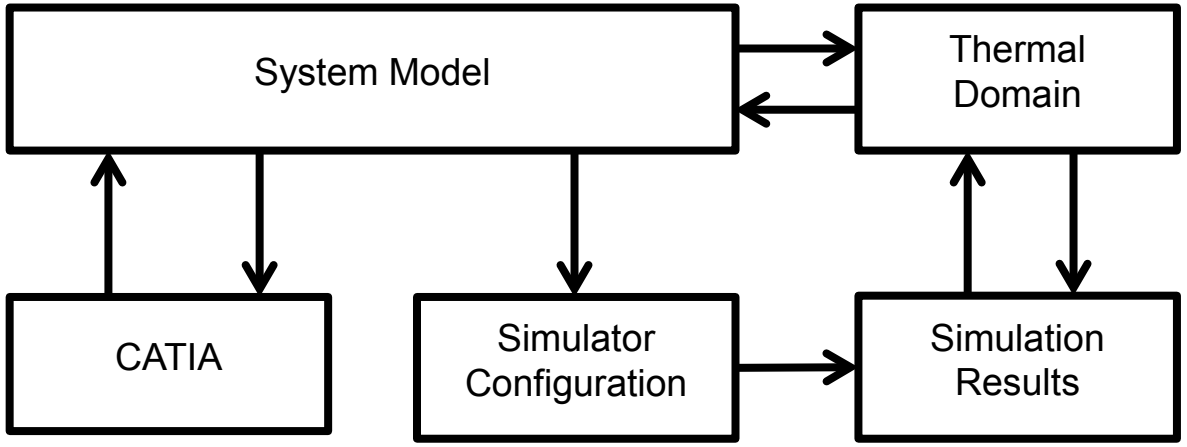
MBSE Aims for Data Continuity Through the Domains

Streamlining design Information with Mechanical Design

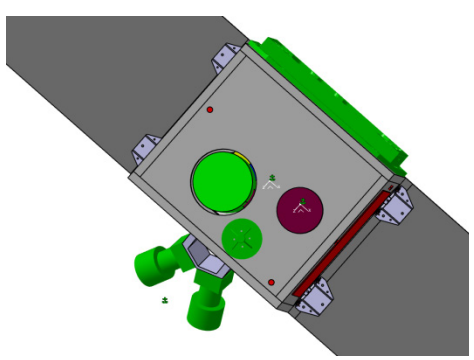
- Mechanical Design is a well established domain
- Mechanical Design is key input to further processing
- A suitable bi-directional exchange between both domains needed

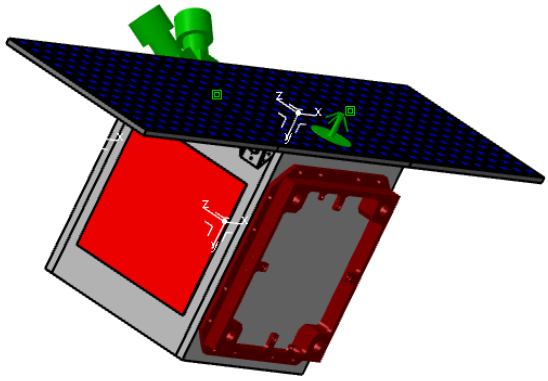


System Model
- Primitive Shapes



Example of using CAD Modell for Simulator Configuration of Thermal Simulation

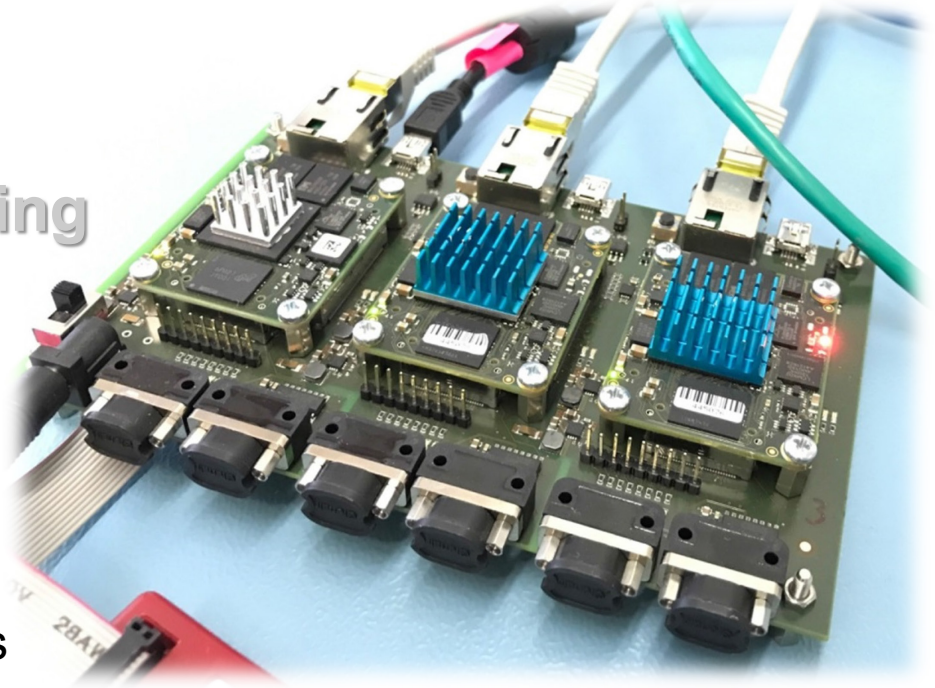




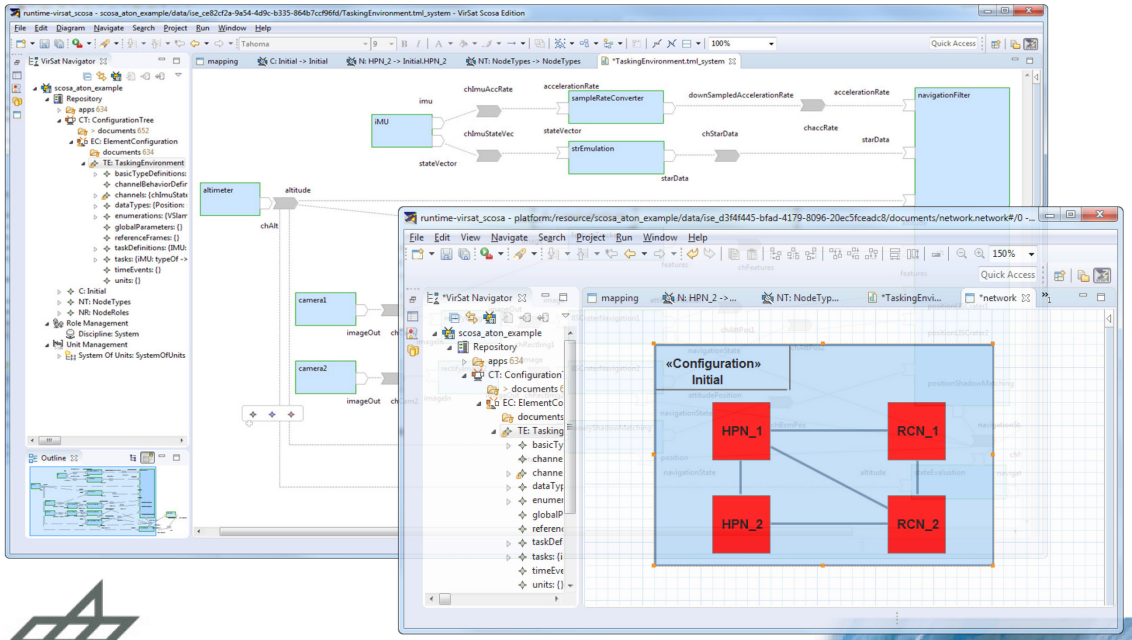
CAD Model
- Complex Shapes
- Mechanical Constraints
- Drilled Holes, Joints etc.

Multiple Tasks on Multiple Processing Nodes

Model Based Approach for Task Node Mapping

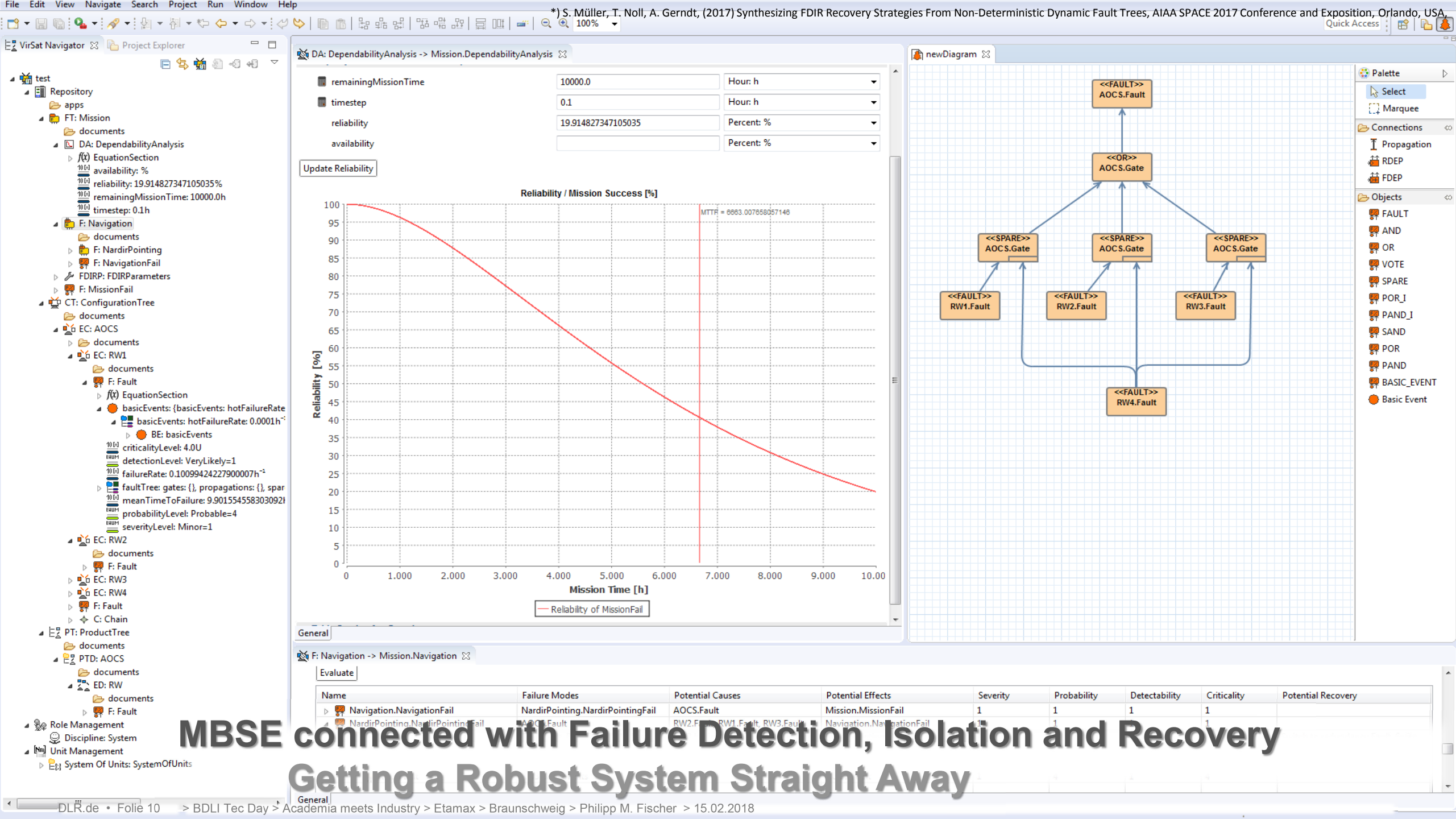


- One computer network for all applications and phases
- Use of cheap high-performance hardware together with radiation-protected space-certified hardware
- Constant health monitoring and automatic reconfiguration after failures



- Modeling network topology and application tasks
- Automatic assignment of tasks to nodes
- Generation of configuration files out of the model

*) A. Kovalov, E. Lobe, A. Gerndt, D. Lüdtke, (2017) Task-Node Mapping in an Arbitrary Computer Network Using SMT Solver, Integrated Formal Methods, DOI: 10.1007/978-3-319-66845-1_12

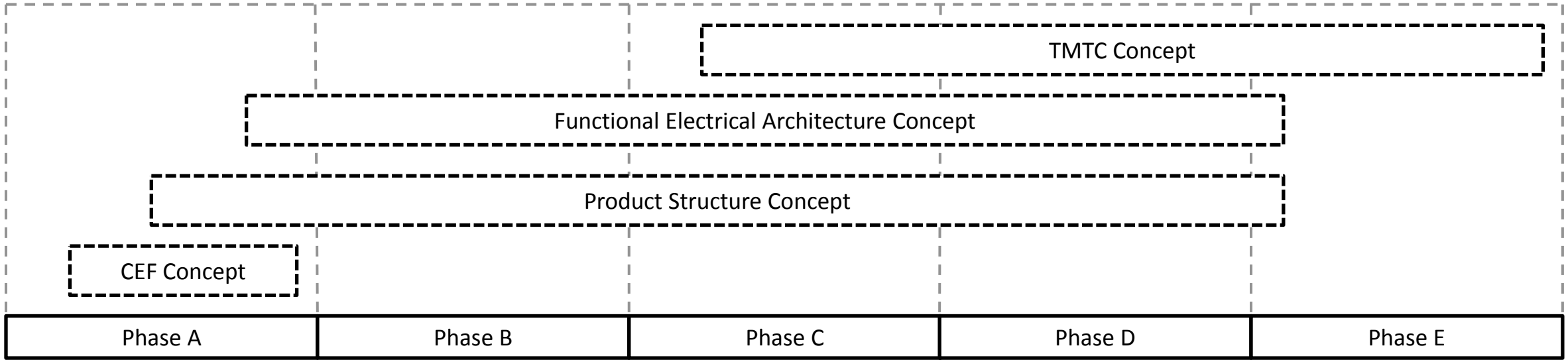


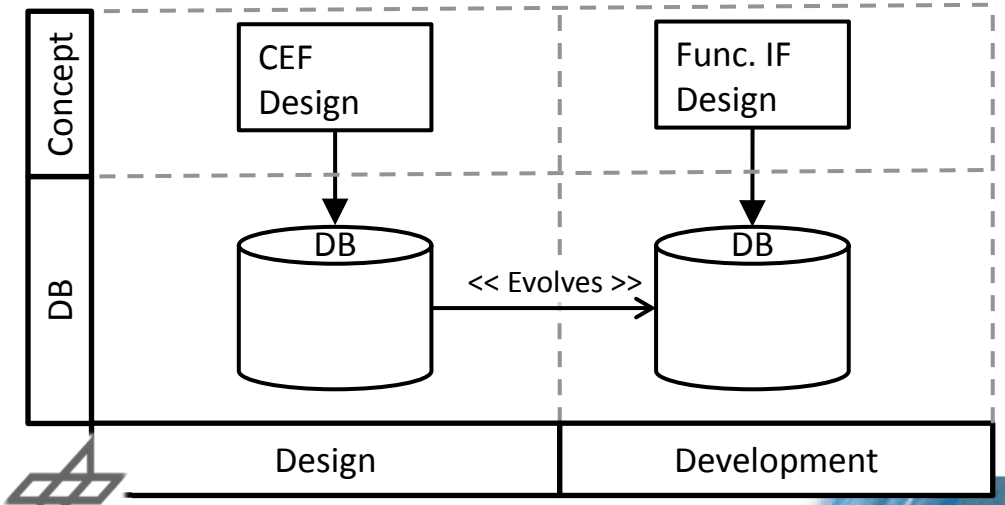
MBSE connected with Failure Detection, Isolation and Recovery

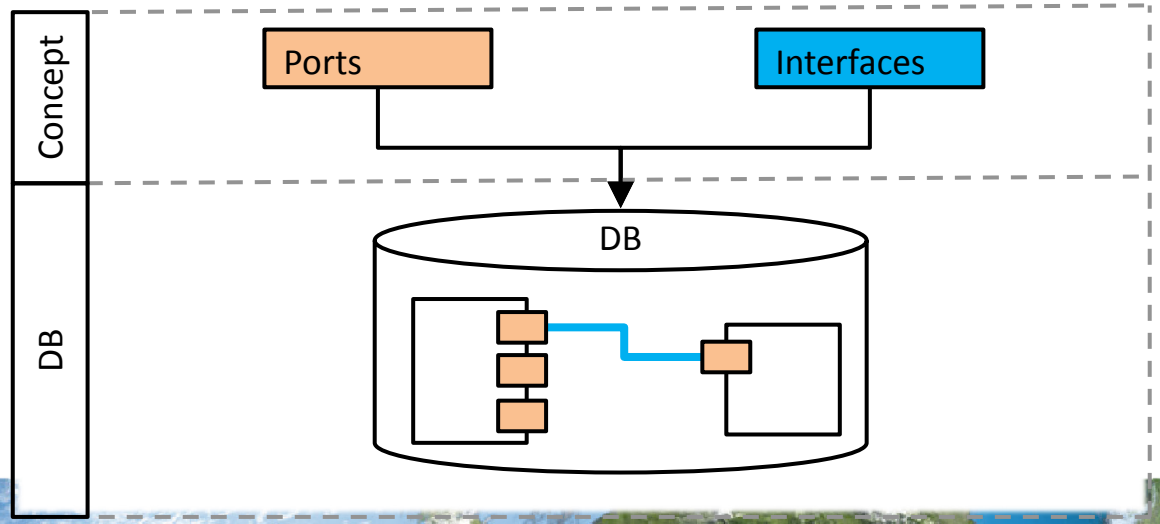
Getting a Robust System Straight Away

Extending the Model When The Requirements of Tomorrow are Known

Our Latest Research to Extend our Data Base Models by Concepts







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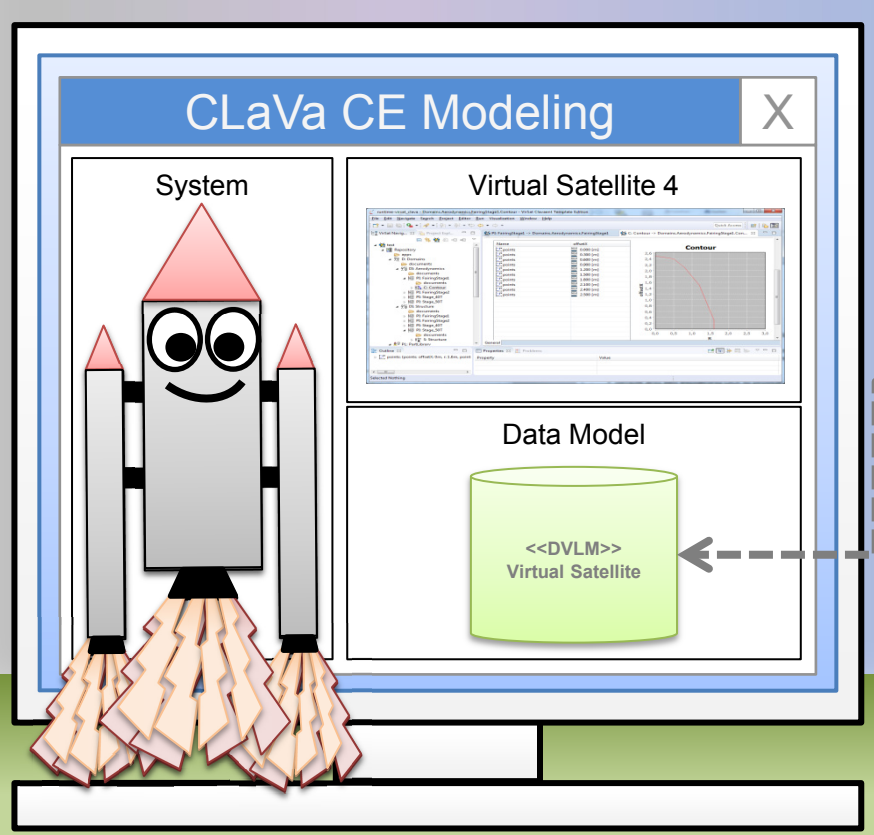
Successful MBSE for Satellites but What About Launchers?

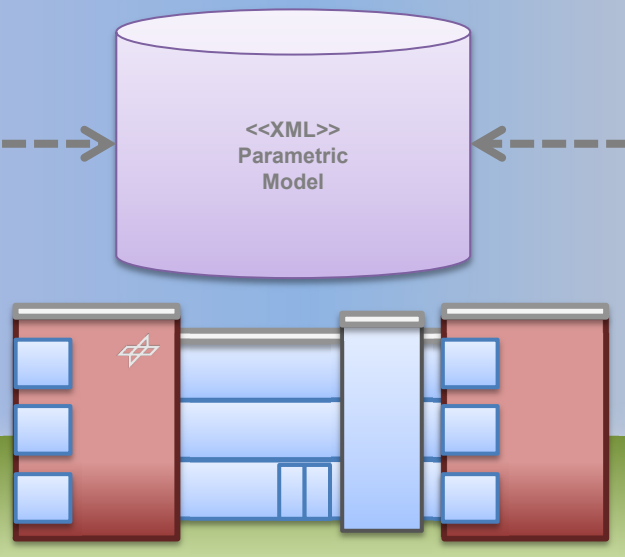
We Have the Tools but we don't yet Fully Understand the Process!

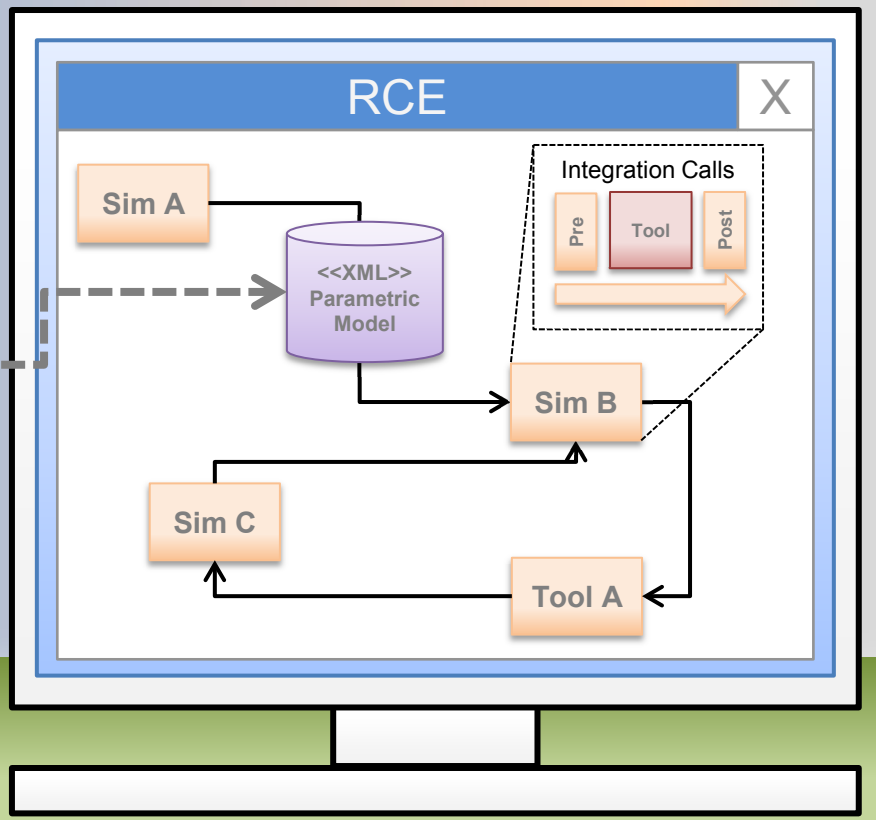
Day 2

Design Analysis → Domain Design → System Design → System Simulation and Offline Work

Domain Experts | System Expert | Simulation Experts

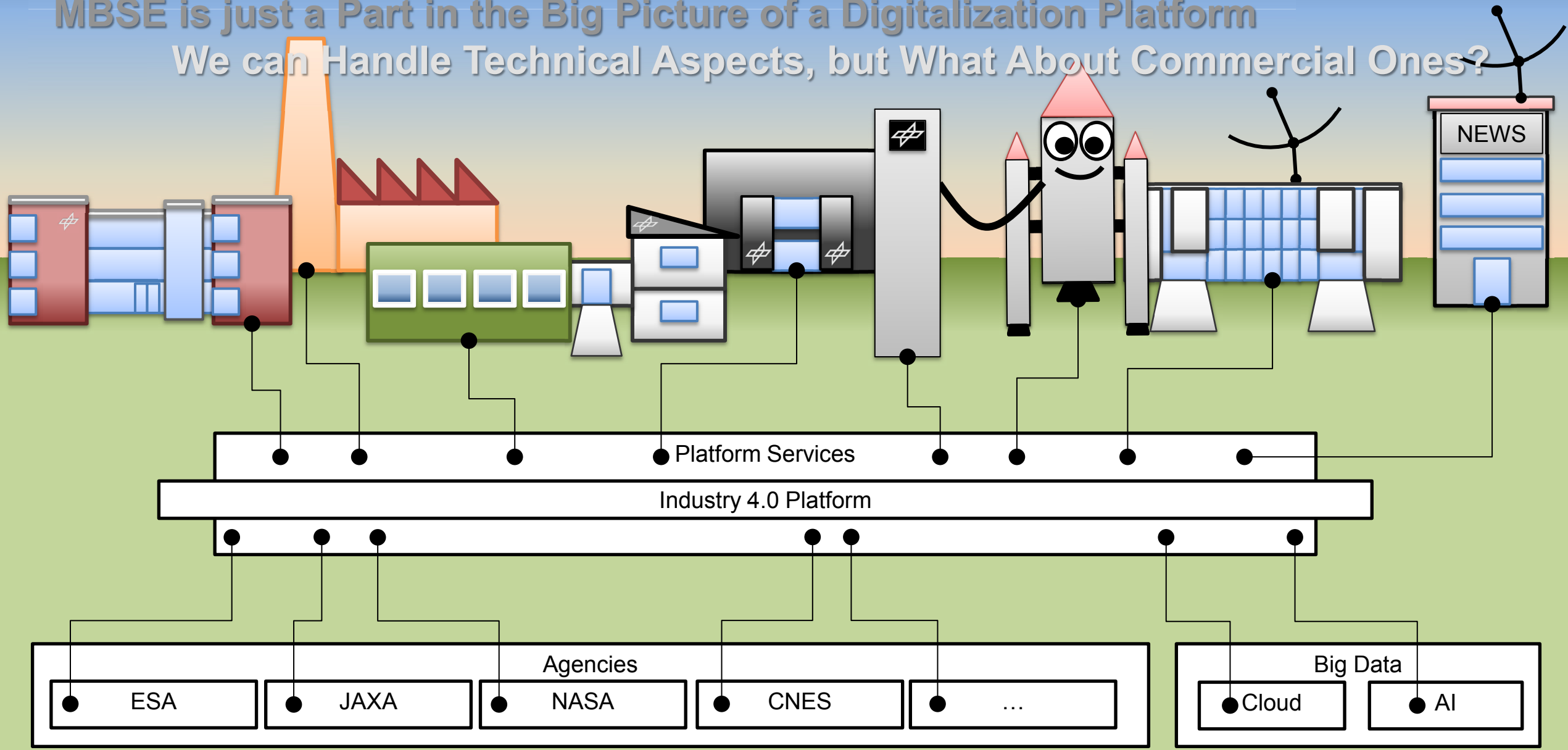






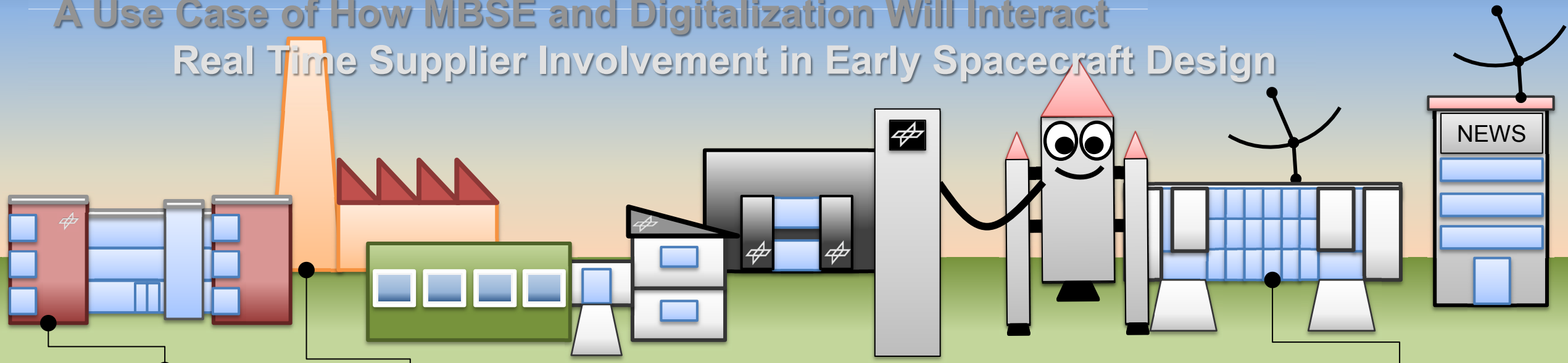
MBSE is just a Part in the Big Picture of a Digitalization Platform

We can Handle Technical Aspects, but What About Commercial Ones?



A Use Case of How MBSE and Digitalization Will Interact

Real Time Supplier Involvement in Early Spacecraft Design



Design (CEF)

CEF

1. Designing Spacecraft
2. Need part following Specification.
3. Transmitting need to Platform
4. Launch windiow in 5 Month.

Supplier 1

- Can deliver but in 6 month

Zulieferer 2

- Can deliver in 2 month.

Zulieferer 3

- Can deliver with small deviations to the spec

GSOC

Wait!!! The equipment of supplier 2 has a high failure rate.

Operations (GSOC)

Researching the Emerging Trends in Digitalization
Integrating Mixed Reality and Cyber Physical Systems

Back to the Question of What is MBSE?

It Remains a Question of What You Make Out of it!

- There is nothing such as the one MBSE that solves all your problems.
- Be precise when talking about MBSE !!!
- Even though you have some MBSE already running. Applying it to a new field can be tricky.
- MBSE is already a huge topic, but we have to see how it fits into the bigger picture of digitalization.
- *If you have questions, give me a call: „Hi Phil! We want to improve MBSE in our Company and Virtual Satellite doesn't help, but we have an idea of adjusting it…" ;-)*

End of Presentation

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